SHIELDED CABLE

BACKGROUND OF THE INVENTION

Field of the Invention

5   The present invention relates to a shielded cable assembly and, more particularly, to a technique for improving electrical characteristics of signal wires in a shielded cable for connection between electronic appliances to improve the quality of

10   signals transmitted through the cable and to effectively suppress radiant noise.

Related Background Art

With the speedup of signal processing in digital signal processors, there has been an

15   increasing need to ensure both maintenance of signal quality and suppression of radiant noise. The need is particularly high in the case of an interface cable for signal transmission between digital appliances because the transmission distance is

20   ordinarily long and because a stable ground to a chassis made of a conductive material cannot be provided in the vicinity of signal wires. For this reason, shielded cables have been used in which a plurality of signal wires in the cable are covered

25   with a braid or the like. In shielded cables having a braided shielding or the like, the braided wire strongly couples with signal wires in cables and

functions as a signal ground. Therefore, shielded
cables are capable of improving the signal quality
while suppressing radiant noise.

FIG. 9 is a cross-sectional view of a shielded
5   cable having thirty-six signal wires held therein.
Referring to FIG. 9, the shielded cable indicated by
101 has single wires A+, A-, B+, B-, C+, C-, D+, D-,
E+, E-, F+, F-, G+, G-, H+, H-, I+, I-, J+, J-, K+,
K-, L+, L-, M+, M-, N+, N-, O, P, Q, R, S, T, U, and
10   V. Each single wire is covered with an insulating
sheathe. Single wire O is a power supply line
connected to a power supply via a connector (not
shown). Seven single wires P, Q, R, S, T, U, and V
are ground lines connected to ground through the
15   connector (not shown). Each of pairs of single wires
A+ and A-, B+ and B-, C+ and C-, D+ and D-, E+ and E-,
F+ and F-, G+ and G-, H+ and H-, I+ and I-, J+ and J-,
K+ and K-, L+ and L-, M+ and M-, and N+ and N- are
twisted together to form fourteen twisted pairs A, B,
20   C, D, E, F, G, H, I, J, K, L, M, and N. Seven pairs
A, B, C, D, E, F, and G in the fourteen twisted pairs
are for transceiving signals at a high rate of 10 MHz
or higher. Seven pairs H, I, J, K, L, M, and N are
for transceiving signals at a low rate of 10 MHz or
25   lower. All the thirty-six signal wires are covered
with an insulating film 2. An outer shield 3 in the
form of a braid or the like is formed outside the

insulating film 2. The outer surface of the outer shield 3 is covered with a jacket 4 made of an insulating material.

In Japanese Patent Application Laid-Open No.
5 H11-213765 is described an arrangement in which single wires for transmitting signals of a relatively high frequency are placed separately from each other in a signal transmission cable for transmitting a plurality of signals of different frequencies. In
10 this manner, crosstalk between signals of a relatively high frequency can be prevented.

In recent years, however, the frequencies of signals flowing through shielded cables have been further increased. In particular, the frequency of a
15 clock signal and a plurality of digital data signals synchronized with the clock signal is 10 MHz or higher. The radiant noise problem has become more serious. Under such circumstances, there are two problems described below with respect to shielded
20 cables based on the above-described conventional art.

The first problem relates to variations in impedance of twisted pairs in the case of transceiving signals at a high rate through a shielded cable. Variation in impedance is a cause of
25 occurrence of radiant noise and failure to maintain the quality of a high-rate signal. Ideally, the characteristic impedance of a twisted pair in a

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single state is determined by the inductance of the
single wires forming the twisted pair and the
capacitive coupling between the two single wires in
the space occupied by the twisted pair. The
5   differential impedance in the case where a
differential signal is transceived through the
twisted pair is determined in the same way.

In actuality, around a twisted pair, conductors,
i.e., single wires other than the twisted pair, exist
10   and the capacitive coupling with the adjacent single
wires considerably affects the impedance of the
twisted pair. With respect to the twisted pair E
shown in FIG. 9 as a line for transceiving a high-
rate signal, the characteristic impedance of the
15   twisted pair E is not determined by the inductance of
the single wires E+ and E- alone. The single wires V
and U, the twisted pair M for transceiving a low-rate
signal and the twisted pairs D and F for high-rate
signals exist around the twisted pair E, and the
20   capacitive coupling with these wires considerably
affects the characteristic impedance of the twisted
pair E. Therefore, the capacitive coupling designed
with respect to the twisted pair cannot be stably
provided and the designed impedance value cannot be
25   realized.

It is difficult in practice to fix the
positional relationship between the twisted pair E

for transceiving a high-rate signal and the single
wires surrounding the twisted pair E by constantly
maintaining through the entire length of the shielded
cable 101 the positional relationship in structure as
5   viewed in section. This is because the twisted pairs
differ in their twisting pitch or the twisted pairs
and the single wires differ in their thickness. The
relationship between the twisted pair E for
transceiving a high-rate signal and the surrounding
10 wires, i.e., the twisted pair M for transceiving a
low-rate signal, the twisted pairs D and F for
transceiving high-rate signals, and the single wires
V and U, changes largely with respect to the position
in the lengthwise direction of the shielded cable 101.
15 The value of capacitive coupling between the twisted
pair E and the surrounding twisted pairs or single
wires is thereby varied largely, resulting in
variation in impedance value of the twisted pair E in
the lengthwise direction of the shielded cable 101.
20   The number of surrounding twisted pairs, the
number of surrounding single wires and the conditions
of the surrounding twisted pairs and single wires
vary with respect to the twisted pairs for high-rate
signals, and there are differences between the
25 relative characteristic impedance values of the
twisted pairs for high-rate signals. In particular,
the twisted pair G shown in FIG. 9 differs largely

from the other twisted pairs A to F in the distance
from the outer shield 3 of the shielded cable 101,
the number of surrounding signal wires and the
conditions of the surrounding signal wires.

5   Therefore, the difference between the impedance value
of the twisted pair G and those of the twisted pairs
A to F is large. This is a cause of generation of
radiant noise.

The second problem relates to a skew which is
10   the difference between delay times of transmitting
signals. In many cases, high-rate signals
transceived through twisted pairs in a shielded cable
are high-rate parallel data such as image data. In
high-rate parallel transmission, it is necessary to
15   minimize the skew with respect to each transmission
path as far as possible. If a skew between signals
is large, a timing margin is reduced and there is a
possibility of failure to receive parallel data. In
the case of the shielded cable 101 shown in FIG. 9,
20   it is necessary to minimize the skew of the twisted
pairs A, B, C, D, E, F, and G for high-rate signals.
For minimization of the skew, equalization of the
physical lengths of the twisted pairs A, B, C, D, E,
F, and G and equalization of the conditions of the
25   conductor and the dielectric surrounding the twisted
pairs A, B, C, D, E, F, and G are required.

The single wires and twisted pairs mixedly

provided in the shielded cable 101 are roughly

divided into those placed in a central layer (twisted

pairs A to F) and those placed in an outer layer

(twisted pairs G to N and single wires O to V). In

5   the process of manufacturing the shielded cable 101,

it is necessary to twist wires so as not to form a

portion in which the cable diameter is relatively

increased. If the twisting pitch in the inner layer

and the twisting pitch in the outer layer are equal

10   to each other, the diameter of the cable assembly is

increased. Ordinarily, therefore, the twisting pitch

in the outer layer is reduced while the twisting

pitch in the inner layer is increased. In the

shielded cable 101, because of the difference between

15   the twisting pitch of the twisted pairs placed in the

inner layer and the twisting pitch of the twisted

pairs placed in the outer layer, the signals wires in

the inner layer and the signal wires in the outer

layer differ largely in physical length from each

20   other. Since in the twisted pairs A to G for high-

rate signals, the twisted pairs A to F positioned in

the inner layer and the twisted pair G positioned in

the outer layer differ in physical length, the skew

is so large that part of parallel data transceived

25   through these signal wires can easily be lost.

The above-described skew problem also occurs at

the connection between a shielded cable and a

connector. The state of wire connection between an
ordinary shielded cable and a connector is
illustrated in (a) and (b) of FIG. 10. Section (a)
of FIG. 10 is a cross-sectional view of a cable 201
5   incorporating single wires L1 to L7 and R1 to R7, and
section (b) of FIG. 10 is a diagram schematically
showing a state in which the single wires L1 to L7
and R1 to R7 are separated from each other and
connected to a connector 210. When the cable is
10   connected to the connector, ends of the bundled
single wires are separated from each other and the
separated single wires are connected one by one to
contact pins of the connector. If intersection
occurs between the single wires when the wires are
15   connected, disconnection or the like may result.
Ordinarily, therefore, the single wires in the cable
201 are parted into halves to be led to left and
right portions of the connector 210. The parted
single wires are connected in the order of L1 to L7
20   leftward from the contact pin nearest to a center of
the connector 210 and in the order of R1 to R7
rightward. At the connection between the shielded
cable and the connector, therefore, there is a large
difference between the wiring length of the signal
25   wires L1 and R1 allocated to the central position of
the connector and the wiring length of the signal
wires L7 and R7 allocated to end portions of the

connector, so that a considerably large skew occurs.

In particular, as shown in Japanese Patent Application Laid-Open No. H11-213765, in a case where high-rate signal wires are placed separately from each other, the distance between some of the signal wires and connector pins of a connector assigned to the signal wires at the connection between the cable and the connector is necessarily large, the difference in wiring length is correspondingly large, and the skew is increased.

For the purpose of stabilizing the characteristic impedance of twisted pairs for transceiving high-rate signals and suppressing the skew, ground and power supply wires may be newly added in the shielded cable or each twisted pair may be covered with an conductive member. In such a case, however, the manufacturing cost of the shielded cable is increased and the handling of the cable becomes troublesome since the number of wiring is increased. Moreover, it cannot be ensured that variation in each twisted pair in the lengthwise direction and variation between twisted pairs are reduced with reliability.

SUMMARY OF THE INVENTION

As means for maintaining improved signal quality and reducing radiant noise more effectively

under circumstances where the rate of transmission of

signals through a shielded cable is further increased,

not only use of a shielded cable simply arranged to

be covered with a braid but also devising the

5 placement of a plurality of single wires and twisted

pairs provided inside the braided shield are required.

Therefore, an object of the present invention is to

provide a shielded cable capable of easily and stably

performing impedance control and skew control of

10 twisted pairs for transceiving high-rate parallel

signals without using cost-increasing means such as

addition of ground and power supply wires.

According to the present invention, there is

provided a shielded cable having first signal wires

15 for transmitting digital signals of a relatively high

frequency, second signal wires for transmitting

digital signals of a relatively low frequency, and a

conductor with which the first and second signal

wires bundled in a state of being electrically

20 insulated from each other are collectively covered,

wherein the first signal wires are placed adjacent to

the conductor and adjacent one to another.

In this invention, it is not necessarily

required that all the plurality of signal wires for

25 transmitting digital signals of a relatively high

frequency be placed in an outermost layer in the

shielded cable. In some case, the majority of the

signal wires may be placed in the outermost layer to achieve the above-described object. Also, it is not necessarily required that all the plurality of signal wires for transmitting digital signals of a

5   relatively high frequency be placed so as to be adjacent one to another. In some case, the majority of the signal wires may be placed in this manner to achieve the above-described object.

According to the present invention, there is

10   also provided a shielded cable in which the first signal wires are twisted pairs.

According to the present invention, there is also provided a shielded cable in which a clock signal of 10 MHz or higher and a plurality of data

15   signals synchronized with the clock signals are transmitted through the first signal wires.

According to the present invention, there is further provided a shielded cable in which the above-described shielded cable has connectors for

20   connection at its opposite ends, each of the connectors having connector pins being connected to the first and second signal wires, the first signal wires being connected to particular ones of the connector pins which are adjacent one to another.

25   The above and other objects of the invention will become more apparent from the following description taken in conjunction with the

accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a shielded

5   cable in a first embodiment of the present invention;

FIG. 2 comprising sections (a) and (b) is a

diagram schematically showing the state of connection

between the shielded cable and a connector in the

first embodiment of the present invention;

10   FIG. 3 is a diagram schematically showing an

apparatus for measuring the impedance of the shielded

cable;

FIG. 4 is a graph showing the results of

measurement of the impedance of the shielded cable in

15   the first embodiment;

FIG. 5 is a graph showing the results of

measurement of the impedance of a conventional

shielded cable;

FIG. 6 is a cross-sectional view of a shielded

20   cable in a second embodiment of the present

invention;

FIG. 7 comprising sections (a) and (b) is a

diagram schematically showing the state of connection

between the shielded cable and a connector in the

25   second embodiment of the present invention;

FIG. 8 is a graph showing the results of

measurement of the impedance of the shielded cable in

the second embodiment of the present invention;

FIG. 9 is a cross-sectional view of a conventional embodiment shielded cable; and

FIG. 10 comprising sections (a) and (b) is a
5 diagram schematically showing the state of connection between the conventional shielded cable and a connector.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10   Preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

(First Embodiment)

FIG. 1 is a cross-sectional view of a shielded
15 cable in a first embodiment of the present invention, showing the placement of single wires and twisted pairs provided in the shielded cable. Thirty-six single wires are placed in the shielded cable. Seven twisted pairs each formed by twisting together two
20 single wires and used to transceive high-rate signals, seven twisted pairs each formed by twisting together two single wires and used to transceive low-rate signals, seven ground lines each formed of a single wire and connected to ground, and one power supply
25 line formed of a single wire and connected to a power supply are placed in the shielded cable. In FIG. 1, the components corresponding to those in the

conventional art described above with reference to
FIG. 9 are indicated by the same reference symbols.

Referring to FIG. 1, the shielded cable
indicated by reference numeral 1 has single wires A+,

5   A-, B+, B-, C+, C-, D+, D-, E+, E-, F+, F-, G+, G-,
H+, H-, I+, I-, J+, J-, K+, K-, L+, L-, M+, M-, N+,
N-, O, P, Q, R, S, T, U, and V each covered with an
insulating sheathe. Each of pairs of single wires A+
and A-, B+ and B-, C+ and C-, D+ and D-, E+ and E-,

10   F+ and F-, G+ and G-, H+ and H-, I+ and I-, J+ and J-,
K+ and K-, L+ and L-, M+ and M-, and N+ and N- are
twisted together to form fourteen twisted pairs A, B,
C, D, E, F, G, H, I, J, K, L, M, and N. Seven pairs
A, B, C, D, E, F, and G in the fourteen twisted pairs

15   are for transceiving signals at a high rate of 10 MHz
or higher. Seven pairs H, I, J, K, L, M, and N are
for transceiving signals at a low rate of 10 MHz or
lower. The single wire O is a power supply line
connected to an external power source via connectors

20   etc., and the seven single wires P, Q, R, S, T, U and
V are ground lines connected to an external ground
via connectors etc. All the thirty-six signal wires
are covered with an insulating film 2. An outer
shield 3 in the form of a braid or the like is formed

25   outside the insulating film 2. The outer surface of
the outer shield 3 is covered with covered with a
jacket 4 made of an insulating material. The

shielded cable 1 is formed by twisting the signal
wires bundled together and by covering the surface of
the bundled signal wires with the insulating film 2,
the outer shield 3 and the jacket 4.

5   Referring to FIG. 1, all of the twisted pairs A,
B, C, D, E, F, and G for transceiving high-rate
signals are placed in an outer layer adjacent to the
outer shield 3. Therefore, each of the twisted pairs
A, B, C, D, E, F, and G is capacitively coupled to

10   the outer shield 3 much more strongly than the
conductors of the other single wires and twisted
pairs existing in the vicinity of the twisted pairs A,
B, C, D, E, F, and G. Therefore, the distance of
each of the twisted pairs A, B, C, D, E, F, and G to

15   the outer shield 3 is a dominant parameter in
determination of the impedance of the twisted pairs.
Since the outer shield 3 is connected to external
ground via a connector or the like, the potential of
the outer shield 3 is constant and the impedance of

20   each of the twisted pairs A, B, C, D, E, F, and G can
be stabilized.

       The twisted pairs A, B, C, D, E, F, and G is in
the same condition with respect to the outer shield 3.
Therefore there is no difference between the

25   impedance values of the twisted pairs. Each of the
twisted pairs A, B, C, D, E, F, and G to be placed in
the outer layer is not positioned in the inner layer

but unfailingly positioned in the outer layer when
the cable is manufactured by twisting together the
single wires and twisted pairs. Therefore, the
distance between each of the twisted pairs A, B, C, D,

5   E, F, and G and the outer shield 3 is constant with
respect to the position in the lengthwise direction
of the shielded cable 1 and there is substantially no
difference between the impedance values of the
twisted pairs. The impedance value of the twisted

10   pairs A, B, C, D, E, F, and G can be easily adjusted
finely by changing the thickness of the insulating
film 2. Thus, the facility with which the shielded
cable is designed is improved.

Since all the twisted pairs A, B, C, D, E, F,

15   and G are placed in the outermost layer in the
shielded cable 1, the twisting pitches of the twisted
pairs can be equalized. As a result, the wiring
lengths of the twisted pairs can be equalized to
reduce the occurrence of a skew in the shielded cable.

20   Since all the twisted pairs A, B, C, D, E, F,
and G shown in FIG. 1 as wires for transceiving high-
rate signals are placed so as to be adjacent one to
another, all connector pins of a connector to which
the twisted pairs A, B, C, D, E, F, and G of the

25   shielded cable 1 are connected can be collectively
wired at adjacent positions at the connection between
the end of the shielded cable and the connector.

The state of wire connection between the shielded cable 1 and a connector 10 is illustrated in (a) and (b) of FIG. 2. Section (a) of FIG. 2 is a cross-sectional view of the same shielded cable 1 as that of the first embodiment shown in FIG. 1, and section (b) of FIG. 2 is a diagram schematically showing a state in which the signal wires are separated from each other and connected to a connector 10.

When the cable is connected to the connector, the bundled single wires and twisted pairs are separated from each other at their ends and the separated single wires are connected one by one to contact pins of the connector 10. When the single wires of the shielded cable 1 are connected, they are parted at a position indicated by a dotted line into halves to be led to left and right portions of the connector 10. The parted single wires are connected in order from one of the contact pins closer to a center of the connector 10. On the left-hand side of the center, the single wires are connected in the order of E-, E+, F-, F+, G-, and G+. On the right-hand side, the single wires are connected in the order of D+, D-, C+, C-, B+, B-, A+, and A-. Thus, the contact pins to which the twisted pairs A, B, C, D, E, F, and G are connected are in adjacent positions, the wiring lengths of the twisted pairs

are generally equal to each other, and the occurrence
of a skew can be reduced.

Measurement of the impedance value of the
shielded cable 1 in the form shown in FIG. 1 was
5   performed by using a measuring apparatus shown in FIG.
3. In FIG. 3, connectors to which the two ends of
the shielded cable are connected are indicated by
reference numeral 5, a time region reflection type of
oscilloscope is indicated by reference numeral 6, and
10   a jig printed circuit board is indicated by reference
numeral 7. Wiring 8 and a connector 9 are mounted on
the surface of the jig printed circuit board 7. The
single wires in the interior of the shielded cable 1
are connected to the contact pins of the connectors 5.
15   Contact pins corresponding to those in the connector
5 are provided in the connector 9 and are connected
to the signal wiring 8. The same number of wiring as
that in the wiring in the interior of the shielded
cable 1 is formed in the wiring 8.

20   The length of the shielded cable 1 used is 1 m.
The diameter of the cable 1 including the jacket 4 is
about 7 mm. The diameter of each single internal
wire is about 0.3 mm. However, the diameter of each
single wire in this embodiment is not limited to this
25   value.

First, the connector 5 at one end of the
shielded cable 1 was attached to the connector 9 on

the jig printed circuit board 7. At this time, the
connector 5 at the other end of the shielded cable 1
was left in an open state. Next, the oscilloscope 6
was connected to the conductor connected to the

5   twisted pair A in the wiring 8 on the jig printed
circuit board 7 to be measured. A step pulse signal
(rise time 70 ps, amplitude 200 mV) was input from
the oscilloscope 6 to the twisted pair A in the
shielded cable 1 through the wiring 8, the connector

10   9 and the connector 5. The reflected waveform when
the signal was input was measured with the
oscilloscope 6, and the impedance of the twisted pair
A at each of different positions in the shielded
cable 1 was calculated from the measured value. The

15   impedance of each of the twisted pairs B, C, D, and E
was also measured in the same manner. FIG. 4 shows
the results of this measurement. The abscissa of FIG.
4 represents the signal propagation time and the
ordinate presents the impedance of each twisted pair.

20   Graphs A to E in FIG. 4 present the results of
measurements of the twisted pairs A to E in the
shielded cable 1 shown in FIG. 1. The shielded cable
1 was designed in advance so that the impedance of
each of the twisted pairs A to E was 100 Ω.

25   The signal propagation time on the abscissa is
the time period during which the signal reflected at
each position in the shielded cable 1 propagates to

return. The propagation time can be read in terms of
the length of the shielded cable 1. That is, the
portion from 1 to 9.5 nsec in FIG. 4 comprises the
measurement results corresponding to the lengths of
5   different sections in the shielded cable 1. That is,
the impedance value at the 1 nsec represents the
impedance at the connection to the connector at the
starting end of the shielded cable 1, while the
impedance value at 9.5 nsec represents the impedance
10   at the connection to the connector at the terminal
end of the shielded cable 1. Each of intermediate
values corresponds to the impedance at the
corresponding position between the starting and
terminal ends of the shielded cable 1.

15   For comparison, the 1 m long shielded cable 101
according to the conventional art shown in FIG. 9 was
also measured with the same measuring apparatus and
by the same measuring method. FIG. 5 shows the
results of this measurement, i.e., the impedance of
20   each of twisted pairs A to E for transceiving high-
rate signals inside the shielded cable 101. The
shielded cable 101 was designed in advance so that
the impedance of each of the twisted pairs A to E was
100 Ω.

25   As can be read from FIG. 4, the impedance of
each of the twisted pairs A to E in the shielded
cable 1 shown in FIG. 1 is within the range from 92

to 100 Ω and the difference from the design value 100
Ω is not larger than 8 Ω throughout the entire
region of the shielded cable 1. The variation in
impedance of each twisted pair·at each position in
5   the shielded cable is not larger than 5 Ω. It can be
said that the impedance of each twisted pair is
generally constant. Also, relative variation in
impedance between the twisted pairs A to E is 5 Ω or
less and the pair-to-pair variation is advantageously
10 very small.·

In contrast, the impedance of the twisted pairs
A to E in the shielded cable 101 shown in FIG. 5
varies 108 to 118 Ω and the difference from the
design value 100 Ω is large, 18 Ω at the maximum. It
15 is also recognized that the variation in impedance of
each twisted pair at each position in the shielded
cable is 5 Ω or larger. Also, relative variation in
impedance between the twisted pairs A to E is
considerably large, i.e., 5 Ω or larger at several
20 points.

Thus, the impedance of each of the twisted
pairs A to E in the shielded cable 1 shown in FIG. 1
as an embodiment of the present invention is
effectively stabilized in comparison with the
25 shielded cable 101 in the case of the conventional
art shown in FIG. 9, and the present invention has
the effect of suppressing radiant noise.

(Second Embodiment)

FIG. 6 is a cross-sectional view of a shielded cable 21 in a second embodiment of the present invention, showing the placement of single wires and twisted pairs provided in the shielded cable 21. Thirty-six single wires are placed in the interior of the shielded cable. Seven twisted pairs each formed by twisting together two single wires and used to transceive high-rate signals, seven twisted pairs each formed by twisting together two single wires and used to transceive low-rate signals, seven ground lines each formed of a single wire and connected to ground, and one power supply line formed of a single wire and connected to a power supply are placed in the shielded cable. In FIG. 6, the components corresponding to those shown in FIG. 1 are indicated by the same reference symbols.

Referring to FIG. 6, all of the twisted pairs A, B, C, D, E, F, and G for transceiving high-rate signals are placed in an outer layer adjacent to an outer shield 3. Also, as shown in FIG. 6, the twisted pairs A, B, and C are placed so as to be adjacent one to another. The twisted pairs D, E, F, and G are also placed so as to be adjacent one to another. A twisted pair H for transceiving a low-rate signal is placed between the groups of twisted pairs A, B, and C and the groups of twisted pairs D,

E, F, and G.

The state of wire connection between the shielded cable 21 and a connector 30 is illustrated in (a) and (b) of FIG. 7. Section (a) of FIG. 7 is a
5 cross-sectional view of the same shielded cable 21 as that shown in FIG. 6, and section (b) of FIG. 7 is a diagram schematically showing a state in which the single wires are separated from each other and connected to connector pins of the connector 30.

10 When the cable is connected to the connector, the bundled single wires and twisted pairs are separated from each other at their ends and the separated single wires are connected one by one to the connector. When the single wires of the shielded
15 cable 21 are connected, they are parted at a position indicated by a dotted line into halves to be led to left and right portions of the connector 30. The parted single wires are connected in order from one of the contact pins closer to a center of the
20 connector 30. On the left-hand side of the center, the single wires are connected in the order of E-, E+, F-, F+, G-, G+, D-, and D+. On the right-hand side, the single wires are connected in the order of H+, H-, C+, C-, B+, B-, A+, and A-.

25 The shielded cable 21 shown in FIG. 6 was measured with the same measuring apparatus and by the same measuring method as those in the first

embodiment. FIG. 8 shows the results of this measurement, i.e., the impedance of each of twisted pairs A to E for transceiving high-rate signals in the shielded cable 21. The shielded cable 21 was

5   designed in advance so that the impedance of each of the twisted pairs A to E was 100 Ω.

As can be understood from the measurement results shown in FIG. 8, the impedance of the shielded cable of this embodiment is substantially

10   the same as that of the shielded cable 1 shown in FIG. 1, and is generally close to the design value 100 Ω throughout the entire region of the shielded cable 21. The variation in impedance of each twisted pair at each position in the shielded cable 21 is not larger

15   than 5 Ω. It can be said that the impedance of each twisted pair is generally constant. Also, relative variation in impedance between the twisted pairs A to E is 5 Ω or less and the pair-to-pair variation is advantageously very small.

20   The construction of the shielded cable in accordance with the present invention is particularly advantageous when the frequency of high-rate signals propagating through the twisted pairs is 10 MHz or higher. That is, presently, radiant noise relating

25   to electronic appliances must be limited in the range from thirty megahertz to several gigahertz. Ordinarily, digital signals have harmonic components

of frequencies about 3 to 20 times higher. Therefore, it is desirable that signals having frequencies higher than 10 MHz be treated as a high-rate signal, and that a shielded cable assembly in which a signal

5   arrangement such as that described above in the description of the embodiments is made be used to transmit such a signal. The signal waveform is shaped by stabilizing the impedance of the shielded cable to reduce harmonic components. In this manner,

10 radiant noise at high frequencies can be reduced.

A clock signal of 10 MHz has a fundamental frequency of 10 MHz and harmonic components of 30 MHz (triple wave), 50 MHz (quintuple wave), ... 210 MHz (21-fold wave). The level of radiant noise in the

15 frequency band of from 30 to 210 MHz of the harmonic components is generally proportional to the amount of current in the frequency band of from 30 to 210 MHz. Therefore, it is possible to reduce the harmonic component current of from 30 to 210 MHz by

20 stabilizing the impedance of the shielded cable and to thereby suppress radiant noise in the frequency band of from 30 to 210 MHz.

According to the present invention, as described above, in a shielded cable which has a

25 plurality of signal wires for transmitting digital signals of a relatively high frequency and a plurality of signal wires for transmitting digital

signals of a relatively low frequency, and in which
the signal wires are bundled in a state of being
electrically insulated from each other and all the
signal wires are collectively covered with a

5   conductor, the plurality of signal wires for
transmitting digital signals of a relatively high
frequency are placed in the outermost layer of the
shielded cable adjacent to the conductor so as to be
adjacent one to another, thus making it possible to

10 easily and stably perform impedance control and skew
control of the signal wires for transceiving high-
rate parallel signals without using cost-increasing
means such as addition of ground and power supply
wires. In particular, the impedance characteristic

15 of the twisted pairs for transceiving high-rate
parallel signals can be set in accordance with the
design value to limit variation in impedance of the
shielded cable in the lengthwise direction and
relative variation between the twisted pairs for

20 transceiving high-rate parallel signals. As a result,
maintenance of improved signal quality and more
reliable suppression of radiant noise can be achieved
even if the rate at which signals are transmitted
through the shielded cable is further increased.

25   The present invention is capable of suppressing
radiant noise more effectively with respect a high-
rate signal which is a clock signal of 10 MHz or

higher or a data signal synchronized with clock
signal of 10 MHz or higher.